38. (New) The catalyst according to Claim 37, wherein said titanium dioxide component comprises titanium dioxide of the anatase type or the rutile type.

39. (New) The catalyst according to Claim 37, wherein the primary particle size of said titanium dioxide is 10 nm or less in diameter.

40. (New) The catalyst according to Claim 37, comprising titanium dioxide that is characterized by an X-ray diffraction (XRD) pattern that is substantially free from patterns other than those assigned to anatase type titanium dioxide.

41. (New) A catalyst having activity under the irradiation of a visible light characterized in that said catalyst comprises titanium dioxide having stable oxygen defects and the ratio of the peak area obtained by X-ray photoelectron spectroscopy assigned to the 1s electrons of oxygen participating in the bonds with titanium to that assigned to the 2p electrons of titanium (O1s/Ti2p) is 1.99 or lower.

42. (New) The catalyst according to Claim 41, wherein said area ratio (O1s/Ti2p) is in a range of from 1.5 to 1.95.

43. (New) The catalyst according to Claim 41, wherein said area ratio (O1s/Ti2p) remains substantially constant for time durations of 1 week or longer.

44. (New) A catalyst having activity under the irradiation of visible light, characterized in that said catalyst comprises titanium dioxide having stable oxygen defects and yields a signal having a g value of from 2.003 to 2.004 in the ESR measured in darkness at 77K under vacuum, provided that it yields a signal higher in intensity than the g value of from 2.003

to 2.004 above when measured at least under the irradiation of light in the wavelength region of from 420 to 600 nm at 77K in vacuum.

45. (New) The catalyst according to Claim 44, wherein a signal assigned to Ti^{3+}, which yields a g value of 1.96 when measured by ESR in darkness at 77K in vacuum, is substantially not observed on said catalyst.

46. (New) A catalyst having activity under the irradiation of a visible light, characterized in that said catalyst is an oxide semiconductor having stable oxygen defects selected from the group consisting of hafnium oxide, zirconium oxide, strontium titanate, titanium oxide-zirconium oxide based complex oxides, and silicon oxide-titanium oxide based complex oxides.

47. (New) A method for producing a catalyst having activity under the irradiation of a visible light, which comprises treating an oxide semiconductor with hydrogen plasma, characterized by performing said treatment in a state substantially free from the intrusion of air into the treatment system.

48. (New) The method for producing a catalyst according to Claim 47, wherein said state substantially free from the intrusion of air into the treatment system is a state in which the vacuum degree inside the tightly sealed system takes at least 10 minutes to make a change of 1 Torr.

49. (New) The method for producing a catalyst according to Claim 47, wherein said oxide semiconductor is selected from the group consisting of titanium dioxide, zirconium oxide, hafnium oxide, strontium titanate, a titanium oxide-zirconium oxide based complex

oxide, or a silicon oxide-titanium oxide based complex oxide.

50. (New) A method for producing a catalyst having activity under the irradiation of a visible light, which comprises treating an oxide semiconductor with a plasma of rare gas, characterized by performing said treatment in a state substantially free from the intrusion of air into the treatment system.

51. (New) The method for producing a catalyst according to Claim 50, wherein said state substantially free from the intrusion of air into the treatment system is a state in which the vacuum degree inside the tightly sealed system takes at least 10 minutes to make a change of 1 Torr.

52. (New) The method for producing a catalyst according to Claim 50, wherein said oxide semiconductor is selected from the group consisting of titanium dioxide, zirconium oxide, hafnium oxide, strontium titanate, a titanium oxide-zirconium oxide based complex oxide, or a silicon oxide-titanium oxide based complex oxide.

53. (New) A method for producing a catalyst having activity under the irradiation of visible light, characterized by introducing ions of a rare gas on at least a portion of the surface of an oxide semiconductor by means of ion implantation.

54. (New) A method for producing a catalyst having stable oxygen defects and activity under the irradiation of a visible light characterized by comprising heating an oxide semiconductor under vacuum.

55. (New) The method for producing a catalyst according to Claim 54, wherein said oxide semiconductor is selected from the group consisting of titanium dioxide, zirconium oxide, hafnium oxide, strontium titanate, a titanium oxide-zirconium oxide based complex oxide, or a silicon oxide-titanium oxide based complex oxide.

56. (New) The method for producing a catalyst according to Claim 47, wherein said oxide semiconductor is an anatase type titanium dioxide.

57. (New) The method for producing a catalyst according to Claim 50, wherein said oxide semiconductor is an anatase type titanium dioxide.

58. (New) A method for producing a catalyst having activity under the irradiation of a visible light, characterized by heating an anatase type titanium dioxide at a temperature of about 400° C or higher under a vacuum of about 1 Torr or lower.

59. (New) A catalyst having activity under the irradiation of a visible light, which was produced by the method of Claim 47.

60. (New) A catalyst having activity under the irradiation of a visible light, which was produced by the method of Claim 50.

61. (New) A catalyst having activity under the irradiation of a visible light, which was produced by the method of Claim 54.

62. (New) The catalyst according to Claim 59, wherein said oxide semiconductor is titanium dioxide, zirconium oxide, hafnium oxide, strontium titanate, a

titanium oxide-zirconium oxide based complex oxide, or a silicon oxide-titanium oxide based complex oxide.

63. (New) The catalyst according to Claim 60, wherein said oxide semiconductor is titanium dioxide, zirconium oxide, hafnium oxide, strontium titanate, a titanium oxide-zirconium oxide based complex oxide, or a silicon oxide-titanium oxide based complex oxide.

64. (New) The catalyst according to Claim 41, wherein said activity under the irradiation of visible light is an oxidation activity or a reduction activity.

65. (New) The catalyst according to Claim 44, wherein said activity under the irradiation of visible light is an oxidation activity or a reduction activity.

66. (New) The catalyst according to Claim 46, wherein said activity under the irradiation of visible light is an oxidation activity or a reduction activity.

67. (New) The catalyst according to Claim 41, wherein said activity under the irradiation of visible light is a decomposition activity for inorganic and organic substances, or a bactericidal activity.

68. (New) The catalyst according to Claim 37, wherein said catalyst is in a granular, a thin-film like, or a sheet-like shape.

69. (New) The catalyst of claim 37, wherein said catalyst material has been provided on the surface of a base material substrate.

70. (New) The catalyst article according to Claim 69, wherein said base material is an exterior wall of a building, an exterior plane of a roof or a ceiling, an outer plane or an inner plane of a window glass, an interior wall of a room, a floor or a ceiling, a blind, a curtain, a protective wall of highway roads, an inner wall inside a tunnel, an outer plane or a reflective plane of an illuminating light, an interior surface of a vehicle, or a plane of a mirror.

71. (New) The method of claim 47, further including the steps of photo decomposing a substance, comprising decomposing the substance to be decomposed by bringing, under the irradiation of a light containing a visible radiation, a medium containing the substance to be decomposed into contact with the catalyst.

72. (New) The method of claim 50, further including the steps of photo decomposing a substance, comprising decomposing the substance to be decomposed by bringing, under the irradiation of a light containing a visible radiation, a medium containing the substance to be decomposed into contact with the catalyst.

73. (New) The method according to Claim 71, wherein said substance to be decomposed is at least one substance selected from the group consisting of inorganic compounds, organic compounds, microorganisms, and tumor cells.

74. (New) The method according to Claim 72, wherein said substance to be decomposed is at least one substance selected from the group consisting of inorganic compounds, organic compounds, microorganisms, and tumor cells.

75. (New) The method according to Claim 73, wherein said medium is water or air.

CLAIM SHEET

37. A catalyst having activity under the irradiation of a visible light comprising titanium dioxide having stable oxygen defects and exhibiting NOx oxidation activity under the irradiation of a visible light at least in the wavelength region of from about 400 to 600 nm.

38. The catalyst according to Claim 37, wherein said titanium dioxide component comprises titanium dioxide of the anatase type or the rutile type.

39. The catalyst according to Claim 37, wherein the primary particle size of said titanium dioxide is 10 nm or less in diameter.

40. The catalyst according to Claim 37, comprising titanium dioxide that is characterized by an X-ray diffraction (XRD) pattern that is substantially free from patterns other than those assigned to anatase type titanium dioxide.

41. A catalyst having activity under the irradiation of a visible light characterized in that said catalyst comprises titanium dioxide having stable oxygen defects and the ratio of the peak area obtained by X-ray photoelectron spectroscopy assigned to the 1s electrons of oxygen participating in the bonds with titanium to that assigned to the 2p electrons of titanium (O1s/Ti2p) is 1.99 or lower.

42. The catalyst according to Claim 41, wherein said area ratio (O1s/Ti2p) is in a range of from 1.5 to 1.95.

43. The catalyst according to Claim 41, wherein said area ratio (O1s/Ti2p)

remains substantially constant for time durations of 1 week or longer.

44. A catalyst having activity under the irradiation of visible light, characterized in that said catalyst comprises titanium dioxide having stable oxygen defects and yields a signal having a g value of from 2.003 to 2.004 in the ESR measured in darkness at 77K under vacuum, provided that it yields a signal higher in intensity than the g value of from 2.003 to 2.004 above when measured at least under the irradiation of light in the wavelength region of from 420 to 600 nm at 77K in vacuum.

45. The catalyst according to Claim 44, wherein a signal assigned to Ti^{3+}, which yields a g value of 1.96 when measured by ESR in darkness at 77K in vacuum, is substantially not observed on said catalyst.

46. A catalyst having activity under the irradiation of a visible light, characterized in that said catalyst is an oxide semiconductor having stable oxygen defects selected from the group consisting of hafnium oxide, zirconium oxide, strontium titanate, titanium oxide-zirconium oxide based complex oxides, and silicon oxide-titanium oxide based complex oxides.

47. A method for producing a catalyst having activity under the irradiation of a visible light, which comprises treating an oxide semiconductor with hydrogen plasma, characterized by performing said treatment in a state substantially free from the intrusion of air into the treatment system.

48. The method for producing a catalyst according to Claim 47, wherein said

state substantially free from the intrusion of air into the treatment system is a state in which the vacuum degree inside the tightly sealed system takes at least 10 minutes to make a change of 1 Torr.

49. The method for producing a catalyst according to Claim 47, wherein said oxide semiconductor is selected from the group consisting of titanium dioxide, zirconium oxide, hafnium oxide, strontium titanate, a titanium oxide-zirconium oxide based complex oxide, or a silicon oxide-titanium oxide based complex oxide.

50. A method for producing a catalyst having activity under the irradiation of a visible light, which comprises treating an oxide semiconductor with a plasma of rare gas, characterized by performing said treatment in a state substantially free from the intrusion of air into the treatment system.

51. The method for producing a catalyst according to Claim 50, wherein said state substantially free from the intrusion of air into the treatment system is a state in which the vacuum degree inside the tightly sealed system takes at least 10 minutes to make a change of 1 Torr.

52. The method for producing a catalyst according to Claim 50, wherein said oxide semiconductor is selected from the group consisting of titanium dioxide, zirconium oxide, hafnium oxide, strontium titanate, a titanium oxide-zirconium oxide based complex oxide, or a silicon oxide-titanium oxide based complex oxide.

53. A method for producing a catalyst having activity under the irradiation of

visible light, characterized by introducing ions of a rare gas on at least a portion of the surface of an oxide semiconductor by means of ion implantation.

54. A method for producing a catalyst having stable oxygen defects and activity under the irradiation of a visible light characterized by comprising heating an oxide semiconductor under vacuum.

55. The method for producing a catalyst according to Claim 54, wherein said oxide semiconductor is selected from the group consisting of titanium dioxide, zirconium oxide, hafnium oxide, strontium titanate, a titanium oxide-zirconium oxide based complex oxide, or a silicon oxide-titanium oxide based complex oxide.

56. The method for producing a catalyst according to Claim 47, wherein said oxide semiconductor is an anatase type titanium dioxide.

57. The method for producing a catalyst according to Claim 50, wherein said oxide semiconductor is an anatase type titanium dioxide.

58. A method for producing a catalyst having activity under the irradiation of a visible light, characterized by heating an anatase type titanium dioxide at a temperature of about 400° C or higher under a vacuum of about 1 Torr or lower.

59. A catalyst having activity under the irradiation of a visible light, which was produced by the method of Claim 47.

60. A catalyst having activity under the irradiation of a visible light, which was produced by the method of Claim 50.

61. A catalyst having activity under the irradiation of a visible light, which was produced by the method of Claim 54.

62. The catalyst according to Claim 59, wherein said oxide semiconductor is titanium dioxide, zirconium oxide, hafnium oxide, strontium titanate, a titanium oxide-zirconium oxide based complex oxide, or a silicon oxide-titanium oxide based complex oxide.

63. The catalyst according to Claim 60, wherein said oxide semiconductor is titanium dioxide, zirconium oxide, hafnium oxide, strontium titanate, a titanium oxide-zirconium oxide based complex oxide, or a silicon oxide-titanium oxide based complex oxide.

64. The catalyst according to Claim 41, wherein said activity under the irradiation of visible light is an oxidation activity or a reduction activity.

65. The catalyst according to Claim 44, wherein said activity under the irradiation of visible light is an oxidation activity or a reduction activity.

66. The catalyst according to Claim 46, wherein said activity under the irradiation of visible light is an oxidation activity or a reduction activity.

67. The catalyst according to Claim 41, wherein said activity under the irradiation of visible light is a decomposition activity for inorganic and organic substances, or a bactericidal activity.

68. The catalyst according to Claim 37, wherein said catalyst is in a granular, a thin-film like, or a sheet-like shape.

69. The catalyst of claim 37, wherein said catalyst material has been provided on the surface of a base material substrate.

70. The catalyst article according to Claim 69, wherein said base material is an exterior wall of a building, an exterior plane of a roof or a ceiling, an outer plane or an inner plane of a window glass, an interior wall of a room, a floor or a ceiling, a blind, a curtain, a protective wall of highway roads, an inner wall inside a tunnel, an outer plane or a reflective plane of an illuminating light, an interior surface of a vehicle, or a plane of a mirror.

71. The method of claim 47, further including the steps of photo decomposing a substance, comprising decomposing the substance to be decomposed by bringing, under the irradiation of a light containing a visible radiation, a medium containing the substance to be decomposed into contact with the catalyst.

72. The method of claim 50, further including the steps of photo decomposing a substance, comprising decomposing the substance to be decomposed by bringing, under the irradiation of a light containing a visible radiation, a medium containing the substance to be decomposed into contact with the catalyst.

73. The method according to Claim 71, wherein said substance to be decomposed is at least one substance selected from the group consisting of inorganic compounds, organic compounds, microorganisms, and tumor cells.

74. The method according to Claim 72, wherein said substance to be decomposed is at least one substance selected from the group consisting of inorganic compounds, organic compounds, microorganisms, and tumor cells.

75. The method according to Claim 73, wherein said medium is water or air.

76. The method according to Claim 74, wherein said medium is water or air.